




## ORIGINAL RESEARCH

# The effect of septal deviation on postoperative quality of life in patients undergoing radiofrequency-assisted turbinate reduction

Narin N. Carmel Neiderman MD, MSc<sup>1</sup>  | Netanela Eisenberg MD<sup>1</sup> |  
Inbar Caspi MD<sup>1</sup> | Nir Halevy MD<sup>1</sup> | Iris Shpigel RN<sup>1</sup> | Tomer Ziv Baran Phd<sup>2</sup> |  
Gilad Horowitz MD<sup>1</sup> | Barak Ringel MD<sup>1</sup>  | Anton Warshavsky MD<sup>1</sup> |  
Avraham Abergel MD<sup>1</sup> 

<sup>1</sup>Department of Otolaryngology–Head and Neck Surgery, Tel-Aviv Sourasky Medical Center, Sackler Faculty of Medicine, Tel-Aviv University, Tel Aviv, Israel

<sup>2</sup>Department of Epidemiology and Preventive Medicine, School of Public Health, Sackler Faculty of Medicine, Tel-Aviv University, Tel Aviv, Israel

**Correspondence**

Avraham Abergel, Department of Otolaryngology–Head and Neck Surgery, 6 Weizmann St., Tel Aviv 6423906, Israel.  
Email: avrahamab@tlvmc.gov.il

**Abstract**

**Objectives:** Inferior turbinate hypertrophy (ITH) and nasal septum deviation are leading causes of chronic nasal obstruction. Radiofrequency ablation (RFA) of hypertrophic inferior turbinates is effective for improving quality of life (QOL). We aim to assess QOL among patients with nasal obstruction associated with ITH and major deviated nasal septum.

**Methods:** A prospective cohort study comparing the difference in improved QOL among patients with and without septal deviation following RFA treatment between March 2016 and June 2019. The patients formed two groups according to their grade of septal deviation. Patients participating filled in QOL questionnaires (Sino-Nasal Outcome Test-22 [SNOT-22] and Nasal Obstruction Symptom Evaluation [NOSE]) Pre- and 2 months postprocedure.

**Results:** All patients demonstrated QOL improvement with no significant difference between those with and those without any degree of deviated septum, as demonstrated by their responses to the SNOT-22 questionnaire ( $p = .29$ ), the NOSE questionnaire ( $p = .93$ ), and the degree of nasal obstruction (question 22 in the SNOT-22 questionnaire) ( $p = .14$ ).

**Conclusion:** We conclude that septal deviation to certain degree does not preclude treatment of ITH with RFA nor does it negatively affect subjective improvement of the patient's QOL. Both those with and those without septal deviation will benefit similarly with regards to subjective QOL improvement.

**KEYWORDS**

inferior turbinate hypertrophy, nasal obstruction, quality of life, radiofrequency ablation, septal deviation turbinate reduction

Narin N. Carmel Neiderman and Netanela Eisenberg contributed equally to this study.

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## 1 | INTRODUCTION

Up to 30% of patients presenting to the Rhinology clinic may suffer from chronic nasal obstruction,<sup>1-3</sup> causes reduced daily functioning and quality of life (QOL).<sup>4,5</sup> Inferior turbinate hypertrophy (ITH) is a leading cause for nasal obstruction. Another common etiology for nasal airway obstruction is septal deviation which is present among 75%–80% of the population.<sup>6</sup> Deviated nasal septum (DNS) can be congenital or acquired as a result of various reasons such as trauma or asymmetric growth. It can be accompanied by ITH as a compensatory mechanism.

Radiofrequency ablation (RFA) is a wave-based technology that utilizes radiofrequency to cause scarring and tissue contraction, and commonly used in various medical fields. It is performed in the rhinology setting in order to reduce inferior turbinate volume. The main advantage of the technique is mucosal sparing: an alternating electrical current is produced in controlled doses by an electrode and applied solely to the submucosal region while maintaining accurate direction and relatively low energy levels. The procedure forms a lesion that undergoes fibrosis as part of the healing process, and shrinks the tissue volume.<sup>5,7-11</sup> The procedure is quick, simple and safe with minimal morbidity. Moreover, it may be carried out “in office,” under topical anesthesia with relatively minor levels of pain. Furthermore, the technique does not require postprocedure bandaging (i.e., tamponade/spdints), therefore, enabling a more convenient healing process for the patient.<sup>7-9</sup>

Alternative procedures to treat ITH include total/partial turbinectomy, submucosal turbinate resection, laser-assisted turbinoplasty, cryotherapy, and chemical/electrical/diathermic coagulation. These procedures are also considered effective, however, their main disadvantage is that they do not spare the mucosa.<sup>7</sup> Significant mucosal lesions may cause side effects and complications, such as pain, hyposmia, bleeding, crusting, and synechia. In addition, they usually require postprocedure bandaging and/or tampons, that cause inconvenience and bear a rare occurrence of toxic shock syndrome, a fatal sequela.

Patients with nasal obstruction due to ITH with mild-to-moderate DNS pose a challenge to the rhinologist with regard to the scope of treatment. The effect on QOL among patients treated with RFA alone compared to combine septoplasty and RFA was addressed in a study by Harrill et al.,<sup>8</sup> who demonstrated no advantage in terms of QOL improvement for the combination of septoplasty with RFA compared to RFA alone. Those authors recommended RFA as a first-line therapy for patients with septal deviation and ITH. In our institution, a tailored treatment is adopted after rhinologic assessment of the patient, and a selected group of patients is offered RFA as a first line treatment instead of the traditional septoplasty and partial turbinectomy.

The main aim of this study is to assess the QOL and nasal obstruction symptoms among patients with nasal obstruction associated with ITH and moderate-to-severe DNS who were found to be suitable for RFA in comparison to patients with nasal obstruction symptoms due to ITH and minor DNS. The study findings will enable the recognition of patients who can benefit from RFA alone, and

thereby tailor therapy according to the initial clinical presentation and avoid unnecessary procedures.

## 2 | MATERIALS AND METHODS

### 2.1 | Study design and patient sample

Consenting patients which were assessed as suitable candidates for RFA as first line treatment were enrolled into a prospective cohort study that was approved by the institutional Review Board at the Tel-Aviv Sourasky Medical Center (0367-18-TLV). We enrolled patients with nasal airway obstruction due to ITH who underwent the RFA procedure between March 2016 and June 2019. Each patient underwent physical examination that included nasal valve assessment by modified Cottle maneuver and lateral nasal wall collapse under forced inspiration. Patients also underwent anterior rhinoscopy and nasal cavity evaluation with flexible endoscopy. All the procedures were performed by a single rhinology specialist in the Tel-Aviv Sourasky Medical Center. Data were collected on the patients' medical history, presenting symptoms, medical treatment, imaging findings, procedure description, and postoperative course were.

The inclusion criteria were age >16 years, ability to consent and understand the questionnaires (Hebrew). Exclusion criteria were significant nasal medical history (e.g., nasal cavity tumor), medical history of diagnosed rhinosinusitis or high index of clinical suspicion for rhinosinusitis, clinical presentation, and physical examination suitable for rhinitis medicamentosa, very anterior or severe degree of septal deviation (4, grading system detailed below), patients with major nasal valve disorder were excluded from the study, diagnosed obstructive sleep apnea, pregnancy, minors (<16 years), inability to give informed consent to participate in the study, inability to fill in a questionnaire or inadequacy of responses to the questionnaires (multiple missing answers), refusal to participate in the study, having contraindications for RFA treatment such as using nonremovable electronic devices that can be affected by the radiofrequency waves (e.g., pacemaker) and inability to undergo local anesthesia.

The study participants were divided into two groups according to their grade of nasal septal deviation condition. The first group (“major deviation”) included patients with moderate (Grade 2) to severe (Grade 3) septal deviation, and the second group included patients with no septal deviation (Grade 0) or minor deviation (“minor deviation”, Grade 1) (Figure 1).

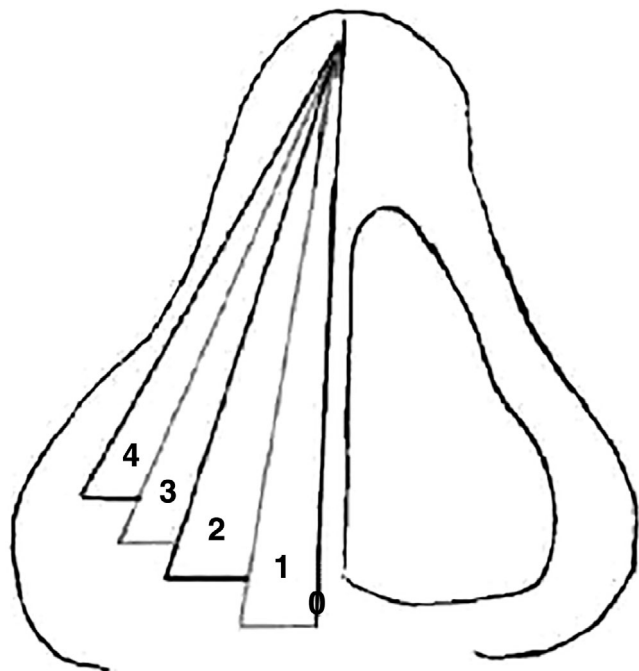
### 2.2 | Subjective QOL assessments

QOL questionnaires (Hebrew validated Sino-Nasal Outcome Test-22 [He-SNOT-22<sup>12</sup>] and Nasal Obstruction Symptom Evaluation [NOSE]) were filled in preoperatively and postoperatively at the follow-up visit 2 months later. Patients were further interviewed/report the overall feeling to their treating doctor (SNOT-22 and NOSE). For long-term follow was contacted 3–4 years post operatively by a rhinology specialist and included a clinical interview and fill out the NOSE questionnaire.

### 2.2.1 | The He-SNOT-22 questionnaire

The He-SNOT-22<sup>12</sup> was used to evaluate changes in individual sub-domains in addition to the overall change<sup>13</sup> in order to increase the sensitivity of the above questionnaire which was originally developed

for rhinosinusitis patients.<sup>14</sup> The minimal clinically important difference (MCID) for the SNOT-22 value of 8.3 (general QOL) was based on Phillips et al's study.<sup>15</sup> We also chose to specifically evaluate changes in question 22, since it deals directly with nasal obstruction and nasal congestion.



**FIGURE 1** Septal deviation grading system

### 2.2.2 | The NOSE questionnaire

In order to evaluate in detail the change in nasal obstruction-related symptoms and their effect on QOL, we also used the NOSE questionnaire. The NOSE questionnaire was developed and validated in 2004 as a tool for evaluating nasal obstruction among adults.<sup>16</sup>

### 2.2.3 | Grading system for nasal septal deviation

Rhinoscopy using nasal speculum and fiber optic examinations were performed by an experienced rhinology specialist who evaluated the anterior septal deviation grade. There is no consensus or gold standard for the best method for grading. We used a grading system that considers the degree of deviation with respect to the nasal cavity, similarly to Salihoglu et al.<sup>17</sup> The contribution of the nasal septum to the degree of obstruction was assessed taking into account the minimal distance between the inferior turbinate and the nasal septum in the narrowest site. The physician rated the septal deviation from 0 (no septal deviation) to 4 (very severe septal deviation) (Figure 1). Since the patients with Grade 4 septal deviation had limited visualization of the obstructed nostril, RFA was not recommended.

**TABLE 1** Clinical presentation, allergic symptoms, and physical examination findings of the study population (N = 68) and comparison of clinical presentation, allergic symptoms, physical examination, between patients with major and minor septal deviation

Feature	Minor septal deviation N = 41 (60.3%)	Major septal deviation N = 27 (39.7%)	p Value	All cohort
Demographic characteristics				
Male	23 (56.1%)	21 (77.8%)	.067	44 (64.7%)
Age	30.87 ± 15.02 25 [20–38]	32.93 ± 18.04 22 [20–45]	.82	31.68 ± 16.19 24 [20–38]
Clinical presentation				
Smoker (n = 36)	2 (9.1%)	0 (0%)	.51	1 (5.6%)
Significant medical history for comorbidities	8 (19.5%)	5 (18.5%)	.92	13 (19.1%)
Allergic symptoms	14 (34.1%)	9 (33.3%)	.945	23 (33.8%)
Diagnosed allergy	10 (24.4%)	4 (14.8%)	.34	14 (20.6%)
Rhinorrhea	11 (26.8%)	9 (33.3%)	.565	20 (29.4%)
Snoring	4 (9.8%)	3 (11.1%)	>.99	7 (10.3%)
Anosmia	5 (12.2%)	2 (7.4%)	.69	7 (10.3%)
History of nasal surgery	8 (19.5%)	1 (3.7%)	.076	9 (13.2%)
Septal deviation		50 (73.5%)		
Degree of septal deviation	None = 18 (26.5%) Minor = 23 (33.8%)	Moderate = 22 (32.4%) Severe = 5 (7.3%)		

Note: Significant medical history = ischemic heart disease, diabetes, hypertension; OSA, obstructive sleep apnea; history of nasal surgery = septoplasty and conchotomy; rhinoplasty. Categorical variables were described as N (%) and continuous variables as mean ± SD, Med [IQR].

**TABLE 2** Results of RFA and quality of life assessment pre- and postprocedure in the study population (N = 68)

Feature	n (%); N = 68
Report of subjective improvement after RFA	58 (85.29%)
Complications	2 (3%)
Revision RF	0 (0%)
Septoplasty and conchotomy performed after RFA	3 (4.4%)
ESS performed after RFA	2 (2.9%)
NOSE questionnaire score	
Before RFA procedure (n = 32)	11.97 ± 4.55 11.5 [9.25–15.5]
After RFA procedure (n = 46)	6.96 ± 4.80 6 [3–10.25]
Score difference (n = 32)	5.41 ± 4.84* 4.5 [1.25–9]
Long term (n = 50)	8.9 ± 4.56 6 [8.5–11.62]
Score difference (n = 25)	3.36 ± 3.78* 3 (6–0.25)
SNOT-22 questionnaire score	
Before RFA procedure	39.52 ± 20.49 39 [25–52.62]
After RFA procedure	27.96 ± 21.70 21.5 [11.625–41]
Score difference	11.51 ± 16.94* 10.5 [1–22.75]
Score improvement <8.3 (MCID)	29 (42.6%)
Score improvement >8.3 (MCID)	39 (57.4%)
Question 22 (Q22 in SNOT-22 questionnaire) score	
Before RFA procedure	3.46 ± 1.45 4 [3–5]
After RFA procedure	2.13 ± 1.63 2 [1–3]
Score difference	1.32 ± 1.69* 1 [0–2]

Note: Complications = prolonged duration of pain during recovery (n = 1) and chronic sinusitis 4 months postprocedure (N = 1). Difference was calculated as score preprocedure minus score postprocedure. Long-term follow-up period was 47 [38.1–53.8] Categorical variables were described as N (%) and continuous variables as mean ± SD, Med [IQR].

Abbreviations: ESS, endoscopic sinus surgery; MCID, minimal clinically important difference; NOSE, Nasal Obstruction Symptom Evaluation; RFA, radiofrequency ablation; SNOT-22, Sino-Nasal Outcome Test-22.

\*p < .001.

## 2.3 | Surgical technique

Local anesthesia was carried out by placing a cotton pledget soaked with tetracaine 2% solution with oxymetazoline (1:1) in the middle and inferior meatus for 15–20 min. Then, under endoscopic vision, 5 cc of 2% lidocaine was injected bilaterally to the inferior turbinates.

The turbinate reduction was carried out with a biolar radiofrequency electrode (Aftmost 15 W automated mode) by creating four to five lesions along the inferior turbinate bilaterally. Lateralization of the turbinates was performed when needed.

Postprocedure, patients performed high flow nasal rinses with saline 0.9% per nostril. Rinses beginning 1–2 days after surgery with a bottle or syringe to squirt the solution into the nose three to four times a day for 2 weeks, afterwards reduced to one to two times a day until the first postoperative clinic visit 2 months after surgery.

## 2.4 | Statistical analysis

Categorical variables were described as frequency in percentage. Continuous variables were evaluated for normal distribution using histograms and Q-Q plots, and described by mean ± standard deviation or by median and interquartile range. The  $\chi^2$  and Fisher's exact tests were applied for the comparison of categorical variables between patients with and without Major septal deviation, and between patients who achieved improvement greater or less than 8.3 (MCID). The independent sample t-test or Mann-Whitney test were employed for examining continuous variables. Questionnaire grades were calculated according to the different subscales, and each patient's delta of improvement was used. A logistic regression was used to identify independent predictors for improvement greater than 8.3. Odd ratios and 95% confidence intervals were reported. The Wilcoxon signed-rank test compared the scores given in the questionnaires before and after the procedure. All the statistical tests were two-tailed, and statistical significance was defined by a p < .05. All statistical analyses were performed with SPSS software (IBM SPSS statistics for Windows, version 25; IBM Corp).

## 3 | RESULTS

### 3.1 | Study population characteristics

Sixty-eight patients met the inclusion criteria and participated in the study between March 2016 and June 2019. Forty-four (64.7%) were men and 24 (35.3%) were women. Their mean ± standard deviation age was 31.7 ± 16.2 years with a median age of 24 (interquartile range: 20–38 years; range 16–75 years). Demographic data, initial presentation and medical history, drugs and habits are described in Table 1. The initial recommendation for all patients was to initiate conservative topical treatment. Twenty-seven (39.70%) patients used topical steroidal nasal spray, but did not benefit from it. The remaining patients did not use the spray consistently or were unwilling to adhere to the regimen.

Physical examination findings upon initial evaluation demonstrated DNS of various degrees in 50 patients (73.5%): 23 (33.8%) had a minor or nonsignificant septal deviation (score = 1), while

**TABLE 3** Demographic and clinical comparison between patients that did and did not achieve a SNOT-22 minimally clinical importance difference (MCID > 8.3) (N = 68)

Feature	<8.3 (MCID) N = 29 (42.6%)	>8.3 (MCID) N = 39 (57.4%)	p Value
Demographic characteristics			
Male	19 (65.5%)	25 (64.1%)	.9
Age	32.155 ± 17.05 28 [20–36.5]	31.33 ± 15.73 22 [20–41]	.88
Clinical presentation			
Smoker (n = 36)	0 (0%)	2 (9.5%)	.5
Significant medical history for comorbidities	5 (17.2%)	8 (20.5%)	.73
Allergic symptoms	10 (34.5%)	13 (33.3%)	.92
Diagnosed allergy	7 (24.1%)	7 (17.9%)	.53
Rhinorrhea	9 (31%)	11 (28.2%)	.8
Snoring	3 (10.3%)	4 (10.3%)	>.99
Anosmia	3 (10.3%)	4 (10.3%)	>.99
History of nasal surgery	5 (17.2%)	4 (10.3%)	.48
Physical examination			
Septal deviation	22 (75.9%)	28 (71.8%)	.71
Degree of septal deviation divided into two groups			
0/1—Minor deviation	15 (51.7%)	26 (66.7%)	
2/3—Major septal deviation	14 (48.3%)	13 (33.3%)	

Note: Significant medical history = ischemic heart disease, diabetes, hypertension. History of nasal surgery = septoplasty conchotomy/rhinoplasty. Categorical variables were described as N (%) and continuous variables as mean ± SD, Med [IQR]. Abbreviations: CT, computed tomography; OSA, obstructive sleep apnea.

22 (32.4%) had moderate septal deviation (score = 2) and 5 (7.4%) had severe septal deviation (score = 3). Eighteen patients (26.5%) did not present with any septal deviation at all (Table 1). The patients were divided accordingly into two groups: the first group consisted of 41 (60.3%) patients with minor to no findings (controls), and the second group consisted of 27 patients (39.7%) who presented with moderate (score = 2) to severe (score = 3) septal deviation (Table 1). Most of the patients (n = 65, 95.6%) were found to have ITH. The turbinates were not clinically hypertrophic in three patients (4.4%) but they contributed to the nasal airway obstruction due to a very narrow nasal cavity (Table 1). As for postsurgical complications, only two patients experienced complications after RFA. One patient reported severe local pain lasting for about 3 weeks following the procedure and resolved gradually over time with over-the-counter analgesics and the other one had excessive crusting, that resolved with topical treatment with nasal douches and topical steroid spray.

### 3.2 | QoL assessment pre- and postoperatively (n = 68)

Table 2 demonstrates the baseline scores and QOL improvement 2 months post-RFA. The QOL improved among the entire study cohort, with the average baseline SNOT-22 mean score decreasing

significantly (from 39.5 ± 20.5 to 28.0 ± 21.7,  $p < .001$ , Table 2). Thirty-two patients had filled in the NOSE questionnaire before the procedure, and 46 patients filled it in after the procedure. The mean NOSE score also decreased significantly (from 12.0 ± 4.6 to 7.0 ± 4.8,  $p < .001$ ) (Table 2). These differences remained statistically significant in long term follow up after 47 [38.1–53.76] months (score difference of 2.5 [2–5],  $p = .01$ ). Question 22, the visual analog score for nasal obstruction assessment, significantly decreased in parallel to the SNOT-22 and NOSE scores, from a baseline of 3.5 ± 1.46 to 2.1 ± 1.6, postoperatively ( $p < .001$ ) (Table 2). None of the patients required revision RFA throughout the study period. Three patients (4.4%) eventually needed a septoplasty due to insufficient improvement of their nasal complaints. Two patients (2.9%) underwent an additional endoscopic sinus surgery, one due to sinusitis that was unrelated to the recovery from RFA procedure, the other due to unsatisfactory improvement that required middle turbinoplasty 2 years and 4 months after the RFA (Table 2).

### 3.3 | QOL among patients with and without DNS

Our data shows no significant difference in clinical presentation, allergic symptoms, physical examination and imaging findings between the groups (Table 1). There was also no significant difference in the

**TABLE 4** Comparison of quality of life assessment between patients with and without clinically significant septal deviation pre- and post-RFA procedure

Feature	Minor septal deviation (0/1 degree) N = 41 (60.3%)	Major septal deviation (2/3 degree) N = 27 (39.7%)	p Value
Report of subjective improvement after RFA	35 (85.4%)	23 (92%)	.7
Complications	1 (2.4%)	1 (3.8%)	.99
Revision RF	0 (0%)	0 (0%)	
Septoplasty and conchotomy performed after RFA	1 (2.4%)	2 (7.4%)	.56
ESS performed after RFA	2 (4.9%)	0 (0%)	.51
NOSE questionnaire score			
Before RFA procedure (n = 32)	12.47 ± 4.98	11.23 ± 3.90	.29
	13 [10–16]	11 [9–14]	
After RFA procedure (n = 46)	7.52 ± 5.13	6 ± 4.14	.32
	7 [3–11.5]	5 [3–8.5]	
Score difference before and after the procedure (n = 32)	5.47 ± 5.39	5.31 ± 4.11	.93
	4 [1–10]	5 [2.5–8]	
Long-term follow-up (n = 49)	9.29 ± 4.99	8.38 ± 3.93	.63
	9 [6–13]	8 [6.5–11.5]	
Score difference before and after the procedure in long term (n = 25)	2.7 ± 3.57	4.3 ± 4.07	.49
	3 [5.5–0]	3.5 [7–0.75]	
SNOT-22 questionnaire score			
Before RFA procedure	42.88 ± 19.64	34.43 ± 21.07	.11
	40 [27.5–57.5]	34 [14.5–49]	
After RFA procedure	29.57 ± 20.53	25.52 ± 23.55	.18
	22 [15–42.5]	16 [10–37]	
Score difference	13.30 ± 15.58	8.80 ± 18.80	.29
	11 [1–24]	8 [(-2)–21]	
Score improvement < 8.3 (MCID)	15 (36.6%)	14 (51.9%)	.21
Score improvement > 8.3 (MCID)	26 (63.4%)	13 (48.1%)	
Question 22 (Q22 in SNOT-22) score difference	1.49 ± 1.78	1.07 ± 1.54	.14
	2 [0–2]	1 [0–2]	
SNOT-22 Subdomains			
Rhinologic symptoms			
Before RFA (n = 64)	14.46 ± 6.79	12.23 ± 7.19	.2
	13.75 [9–20]	11.75 [5.75–18]	
After RFA (n = 66)	11.26 ± 6.55	9.26 ± 7.12	.18
	11 [6–16]	8 [3–13]	
Score difference before and after the procedure (n = 62)	3.29 ± 5.26	3.115 ± 6.40	.77
	3.5 [0.25–6.75]	1.5 [(-1.375)–10]	
Extranasal rhinologic symptoms			
Before RFA (n = 63)	5.14 ± 3.56	4.11 ± 4.15	.15
	5 [2–7]	3 [0–7]	
After RFA (n = 65)	4.024 ± 3.12	3.375 ± 3.70	.24
	4 [1.5–6]	2 [0.25–4.75]	
Score difference (n = 60)	1.03 ± 2.80	0.75 ± 3.57	.56
	1 [(-1)–3]	0 [(-1.75)–2.75]	

TABLE 4 (Continued)

Feature	Minor septal deviation (0/1 degree) N = 41 (60.3%)	Major septal deviation (2/3 degree) N = 27 (39.7%)	p Value
Ear and facial symptoms			
Before RFA (n = 66)	6.21 ± 4.75	4.29 ± 4.40	.09
	6 [3–8]	2.5 [1–6.5]	
After RFA (n = 66)	5.275 ± 4.96	4.365 ± 5.29	.28
	4 [2–6]	2.5 [0–7]	
Score difference before and after the procedure (n = 64)	1.115 ± 3.26	–0.14 ± 4.595	.28
	1 [0–3]	0 [–2.5]–3.5]	
Psychologic dysfunction symptoms			
Before RFA (n = 66)	15.025 ± 9.19	11.60 ± 8.95	.4
	14 [7–23]	10 [4–16.25]	
After RFA (n = 66)	9.27 ± 8.21	8.11 ± 8.88	.36
	7 [2–14]	7 [0–12]	
Score difference (n = 64)	6.04 ± 8.41	3.29 ± 6.93	.23
	5 [0.75–13.25]	4 [0–6.25]	
Sleep dysfunction symptoms			
Before RFA	12.15 ± 6.52	10.09 ± 6.74	.21
	12 [6.5–26]	9 [6–15]	
After RFA (n = 67)	7.925 ± 6.78	6.67 ± 7.12	.37
	6 [3–13]	6 [0–9]	
Score difference (n = 67)	4.475 ± 5.53	3.425 ± 5.375	.6
	4 [1.25–8]	4 [0–7]	

Note: Complications = prolonged duration of pain during recovery (n = 1) and chronic sinusitis 4 months postprocedure (N = 1). Difference was calculated as score preprocedure minus score postprocedure. Long-term follow-up period was 47 [38.1–53.8]. Categorical variables were described as N (%) and continuous variables as mean ± SD, Med [IQR].

Abbreviations: ESS, endoscopic sinus surgery; MCID, minimal clinically important difference; NOSE, Nasal Obstruction Symptom Evaluation; RFA, radiofrequency ablation; septoplasty, submucosal resection of septum; SNOT-22, Sino-Nasal Outcome Test-22.

SNOT-22 questionnaire score between the groups with or without major DNS as derived from a comparison between the decrease in the SNOT-22 questionnaire (8.8 ± 18.8 vs. 13.3 ± 15.6,  $p = .29$ , respectively), or the postoperative scores (25.5 ± 23.6 vs. 29.6 ± 20.5,  $p = .18$ , respectively) (Table 3). Furthermore, evaluation of the different subdomains of SNOT-22 questionnaire revealed no significant differences between patients with and without major DNS (Table 3). There was also no significant difference in the rate of patients who achieved a SNOT-22 score greater than MCID value [13 patients (48.1%) vs. 26 (63.4%), respectively,  $p = .213$ ] (Table 3). The NOSE questionnaire scores likewise showed no significant difference in the overall improvement between the patients with or without significant DNS (5.3 ± 4.1 vs. 5.5 ± 5.4,  $p = .93$ , respectively). Also, in long-term follow-up, no significant differences were found between patients with and without significant DNS (score difference of 2.7 ± 3.57 vs. 4.3 ± 4.07,  $p = .49$ ). As for the SNOT-22 question no. 22 (an analog scale of nasal obstruction) score, it, too, revealed no significant difference between the groups (Table 3). The need for further operative intervention was similarly not statistically significant different between the groups.

### 3.4 | Comparison between patients that achieved improvement in SNOT-22 score greater and lower than 8.3 (MCID)

We divided the cohort into two groups according to whether or not they achieved an MCID >8.3: 39 patients (57.4%) did and 29 patients (42.6%) did not (Table 2). There also was no significant differences in clinical presentation and characteristics between those two groups of patients (Table 4). Interestingly, severity of septal deviation was not related to the achievement of clinically significant improvement according to the SNOT-22 scores (Table 4).

There was a significant decrease in the NOSE questionnaire baseline and postoperative scores between the patients who achieved MCID and those who did not (from 12.0 ± 4.6 to 7.0 ± 4.8, respectively,  $p < .001$ ) (Table 2). It is worth noting that patients who achieved clinically significant improvement (MCID > 8.3) in their SNOT-22 score also had a significantly better improvement in their NOSE scores (mean difference 3.7 ± 3.8 vs. 7.1 ± 5.2,  $p = .042$ ). However, question 22 in the SNOT-22 questionnaire did not reflect a similarly significant difference (Table 5). We performed a logistic

**TABLE 5** Comparison between patients that did and did not achieve a SNOT-22 minimally clinical importance difference (MCID > 8.3)

Feature	<8.3 (MCID) N = 29 (42.6%)	>8.3 (MCID) N = 39 (57.4%)	p Value
Report of subjective improvement after RFA (n = 66)	22 (81.5%)	36 (92.3%)	.26
Complications	0 (0%)	2 (5.1%)	.51
Septoplasty and conchotomy performed after RFA	1 (3.4%)	2 (5.1%)	>.99
ESS performed after RFA	1 (3.4%)	1 (2.6%)	>.99
NOSE questionnaire score			
Before RFA procedure (n = 32)	10.69 ± 5.30	13.25 ± 3.34	.16
	11 [7.25–14]	13.5 [10.25–16]	
After RFA procedure (n = 46)	8.21 ± 4.40	6.07 ± 4.945	.06
	8 [4–11]	5 [2–9]	
Score difference (n = 32)	3.69 ± 3.82	7.125 ± 5.24	.042
	3 [1–5]	8 [3.25–10]	
SNOT-22 questionnaire score			
Before RFA procedure	34.33 ± 21.06	43.385 ± 19.44	.082
	35 [14.5–47.5]	41 [29–57]	
After RFA procedure	37.52 ± 22.88	20.86 ± 17.97	
	36 [16–56.5]	16 [10–27]	
Score difference	–3.29 ± 11.50	22.525 ± 10.79	.41
	0 [–7.5]–5.5]	21 [13–30.5]	
Question 22 (Q22 in SNOT-22) score difference	0.41 ± 1.64	2 ± 1.395	.91
	0 [0–1]	2 [1–3]	

Note: Complications = prolonged duration of pain during recovery (n = 1) and chronic sinusitis 4 months postprocedure (n = 1). Difference was calculated as score prior to procedure minus score postprocedure. Categorical variables were described as N (%) and continuous variables as mean ± SD, Med [IQR]. Abbreviations: MCID, minimal clinically important difference; NOSE, Nasal Obstruction Symptom Evaluation; RFA, radiofrequency ablation; SNOT-22, Sino-Nasal Outcome Test-22.

**TABLE 6** Regression model predicting MCID > 8.3

Variable	OR	CI	p Value
SNOT-22 score pre	1.02	0.99–1.05	.11
PO antihistamine usage	0.127	0.018–0.912	.04
Sex (male)	1.41	0.41–4.88	.58
Age	0.98	0.94–1.04	.56
Prior nasal operation	0.34	0.06–1.95	.23
Degree of deviation	0.49	0.15–1.55	.22

Abbreviations: CI, confidence interval; MCID, minimal clinically important difference; OR, odds ratio; SNOT-22, Sino-Nasal Outcome Test-22.

regression analysis to further determine the significance of DNS degree of deviation and it was not found to be a significant predictor in the context of achieving MCID > 8.3 (Table 6).

## 4 | DISCUSSION

QOL evaluation is a key part of patient assessment in rhinology due to low correlation between objective measures of nasal obstruction, such as rhinometry, nasal inspiratory peak flow and physical examination of the nasal cavity, and the patient's

symptoms and experience.<sup>18</sup> The first therapeutic aim for the majority of cases is to improve the patient's QOL. We used as mentioned two validated patient-reported outcome measures to evaluate our results of surgical intervention to alleviate nasal airway obstruction among our cohort, one is the He-SNOT-22 questionnaire, which is designed to evaluate chronic rhinosinusitis symptoms among Hebrew-speaking patients and the other is the NOSE questionnaire, which is used to evaluate patients with nasal airway obstruction. These two questionnaires are complementary to each other in evaluating all QOL-related aspects in patients undergoing inferior turbinate reduction by means of RFA. In our study, 41 patients (60.3%) had a minor or non-significant septal deviation (score 0–1), and 27 (39.7%) had a moderate to significant septal deviation (score 2–3).

In our cohort, RFA of the inferior turbinate significantly improved the QOL, as reflected in both the He-SNOT-22 and NOSE questionnaire scores ( $p < .001$ ). The He-SNOT-22 scores of 39 patients (57%) revealed clinically significant improvement ( $\Delta$ SNOT score > 8.3). We compared the patients who achieved an MCID > 8.3 to those who did not, and we found no statistically significant differences between them in septal deviation ( $p = .71$ ) or severity of deviation ( $p = .21$ ) (Table 4). DNS did not pose a limitation in achieving improvement greater than the MCID value and, thereby did not limit the potential to obtain improvement in QOL after undergoing RFA.



A comparison between patients who were estimated to have major septal deviation and those with minor significant septal deviation yielded no significant difference between them with regard to their QOL scores in all parameters (He-SNOT-22, NOSE Q22; Table 3), including the different subdomains of the He-SNOT-22 (Table 3). Therefore, we can conclude that apart from patients with very anterior septal deviation or completely obstructive (score = 4), the majority of patients septal deviation of various degrees may be suitable candidates from this procedure. Considering the advantages of this procedure, these results support the position that moderate DNS should not be regarded as a contraindication for RFA and might be considered as first-line treatment in these cases.

Şapçı et al.<sup>19</sup> performed a random controlled trial comparing RFA to alternative procedures to alleviate ITH (i.e., CO<sub>2</sub> laser ablation and partial turbinectomy). They assessed both subjective as well as objective measures of nasal function and reported that RFA was not only efficient but also had a shorter time span to subjective improvement. They also observed that RFA resulted in a significant decline in nasal airway resistance while maintaining mucociliary function. These advantages combined with its “in office” compatibility further supports consideration of RFA as a first-line treatment of ITH.

The effect on QOL among patients treated with RFA alone compared to those treated with combined septoplasty and RFA was addressed in a prospective non-randomized study by Harrill et al.<sup>8</sup> In that study, QOL was evaluated among 77 patients via the NOSE questionnaire preoperatively and 3 and 6 months, postoperatively. Both groups demonstrated significant QOL improvement (RFA alone  $p < .001$  and RFA with septoplasty  $p = .023$ ), similarly to our results. There also were no significant differences between their study groups ( $p = .304$ ).

None of the patients in our cohort underwent revision RFA throughout the study period. Only five patients (7.3%) required additional procedures. These results demonstrate the efficacy of RFA in the patients' subsequent QOL. Hytönen et al.<sup>11</sup> reviewed 35 studies to determine the efficacy of RFA as treatment of nasal airway obstruction due to ITH. Those authors observed that RFA turbinate reduction was efficient, safe, caused minimal inconvenience, and was associated with a relatively low rate of side effects and complications. The procedure was also effective in the long term without significant symptom recurrence after 4 years.

Our study has several limitations arising from its prospective nature, among them are single tertiary center with limited sample size. Lateralization of the inferior turbinate was performed according to clinical judgment during the procedure, adding a possible selection bias to the study. Nevertheless, lateralization of the inferior turbinate is usually made upon clinical judgment thus it should not significantly bias the results.

Since there might have been a reporting bias due to the use of “in office” questionnaires, we also assessed each patient's subjective improvement. The He-SNOT-22 questionnaire is a ubiquitous tool in the assessment of nasal obstruction-related QOL and the best sinonasal scoring system to date.<sup>20</sup> However it is important to note that it was originally developed for rhinosinusitis assessment.<sup>21,22</sup> We added the NOSE questionnaire throughout the study because of its relevance to nasal airway obstruction due to septal deviation when relevant.

Nasal obstruction is challenging for objective assessment. It is mainly addressed as a combination of patient complaints and physical examination findings. However, a limitation of our study was that objective measurements, that is, rhinometry were not used as part of the initial patient assessment. Another limitation of the study is The Grading system we used to score septal deviation. It is based on examiners' subjective assessment of the severity of septal deviation and its implication on nasal obstruction, without adjusting to specific common sites of obstruction. Unfortunately, there is no ubiquitous grading system for nasal obstruction and no specific anatomic sites were found to reflect or correlate more than others to the severity of obstruction.<sup>23,24</sup> Another study found that NOSE scores were not significantly associated with DNS types and angles as reflected on CT imaging.<sup>25</sup> Nevertheless, patients with very anterior deviations were excluded because they were unlikely to benefit from RFA as sole treatment modality.

A prior literature review did not reveal any study that compared the effectiveness of RFA with that of turbinectomy without septoplasty. RFA may be as efficient as turbinectomy in mild cases of DNS and ITH, and even preclude the need for a larger surgery under general anesthesia with longer recovery time and risk of complications.

In conclusion, our study findings show that patients with moderate and severe septal deviation are suitable candidates for RFA, with the expectation of major improvement of QOL, similarly to patients with nonsignificant or mild DNS. RFA was further demonstrated as being an easily available procedure, with an prompt and eventless recovery process and a low rate of sequelae, failures, and recurrences and complications.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ORCID

Narin N. Carmel Neiderman  <https://orcid.org/0000-0003-0628-1942>

Barak Ringel  <https://orcid.org/0000-0003-3355-4651>

Avraham Abergel  <https://orcid.org/0000-0002-9360-8888>

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